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मानक

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IS 14570 (2012): Electrical Measuring Transducers for Converting a.c. Electrical Quantities to Analogue or Digital Signals [ETD 12: Measuring Equipment for Basic Electrical Quantities]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

ए.सी. विद्युत मात्राओं अथवा एनालॉग या डिजिटल संकेतों
को परिवर्तित करने के लिए विद्युत मापन ट्रांसड्यूसर्स
(पहला पुनरीक्षण)

Indian Standard

ELECTRICAL MEASURING TRANSDUCERS FOR
CONVERTING ac ELECTRICAL QUANTITIES
TO ANALOGUE OR DIGITAL SIGNALS
(*First Revision*)

ICS 17.220.20

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

NATIONAL FOREWORD

This Indian Standard (First Revision) which is identical with IEC 60688 : 2002 'Electrical measuring transducers for converting a.c. electrical quantities to analogue or digital signals' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Measuring Equipment for Basic Electrical Quantities Sectional Committee and approval of the Electrotechnical Division Council.

This standard was first published in 1998. This revision has been undertaken in order to align with the latest version of IEC 60688 : 2002.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
- b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
IEC 60050 (301, 302, 303) : 1983 International Electrotechnical Vocabulary (IEV) — Chapter 301: General terms on measurements in electricity. Chapter 302: Electrical measuring instruments	IS 1885 (Part 80) : 1994 Electrotechnical vocabulary: Part 80 General terms on measurements in electricity	Identical to IEC 50-301 : 1983
	IS 1885 (Part 81) : 1993 Electrotechnical vocabulary: Part 81 Electrical measuring instruments	Identical
IEC 60051-1 : 1997 Direct acting indicating analogue electrical measuring instruments and their accessories — Part 1: Definitions and general requirements common to all parts	IS 1248 (Part 1) : 2003 Direct acting indicating analogue electrical measuring instruments and their accessories: Part 1 Definitions and general requirements	Technically Equivalent
IEC 60068-2-3 : 1985 Environmental testing — Part 2: Test Ca: Damp heat, steady state	IS 9000 (Part 4) : 1979 Basic environmental testing procedures for electronic and electrical items: Part 4 Damp heat (steady state)	do
IEC 60255-4 : 1976 ¹⁾ Electrical relays — Part 4: Single input energizing quantity measuring relays with dependent specified time	IS 3231 (Part 1/Sec 3) : 1986 Electrical relays for power system protection: Part 1 General requirements, Section 3 High frequency disturbance test for static relays	do

¹⁾ This publication has been replaced by IEC 60255-3 : 1989.

Indian Standard

ELECTRICAL MEASURING TRANSDUCERS FOR
CONVERTING ac ELECTRICAL QUANTITIES
TO ANALOGUE OR DIGITAL SIGNALS

(First Revision)

1 Scope

This International Standard applies to **transducers** with electrical inputs and outputs for making measurements of a.c. electrical quantities. The output signal may be in the form of an analogue direct current or in digital form. In this instance, that part of the transducer utilized for communication purposes will need to be compatible with the external system.

This standard applies to measuring **transducers** used for converting alternating electrical quantities such as:

- current
- voltage
- active power
- reactive power
- power factor
- phase angle
- frequency

to an **output signal**.

Within the **measuring range**, the **output signal** is a function of the measurand. An **auxiliary supply** may be needed.

This standard applies:

- a) if the nominal frequency of the input(s) lies between 5 Hz and 1 500 Hz;
- b) if a measuring **transducer** is part of a system for the measurement of a non-electrical quantity, this standard may be applied to the **electrical measuring transducer**, if it otherwise falls within the scope of this standard;
- c) to **transducers** for use in a variety of applications such as telemetry and process control and in one of a number of defined environments.

This International Standard is intended:

- to specify the terminology and definitions relating to **transducers** whose main application is in electrical power engineering, especially for the purposes of process control and telemetry systems;
- to unify the test methods used in evaluating **transducer** performance;
- to specify **accuracy** limits and output values for **transducers**.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050(301, 302, 303):1983, *International Electrotechnical Vocabulary (IEV). Chapter 301: General terms on measurements in electricity. Chapter 302: Electrical measuring instruments. Chapter 303: Electronic measuring instruments*

IEC 60051-1:1997, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 1: Definitions and general requirements common to all parts*

IEC 60068-2-3:1985, *Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state*

IEC 60255-4*:1976, *Electrical relays – Part 4: Single input energizing quantity measuring relays with dependent specified time*

IEC 60521:1988, *Class 0,5, 1 and 2 alternating-current watt-hour meters*

IEC 61000-4, *Electromagnetic compatibility (EMC) – Part 4: Testing and measuring techniques*

IEC 61010-1:2001, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements*

NOTE Refer to annex A for the list of informative references.

3 Definitions

For the purpose of this International Standard the following definitions apply:

3.1 General terms

3.1.1

electrical measuring transducer (hereinafter designated "transducer")

a device for converting an a.c. measurand to a direct current, a direct voltage or a digital signal for measurement purposes

3.1.2

auxiliary supply

an a.c. or d.c. electrical supply, other than the measurand, which is necessary for the correct operation of the **transducer**

3.1.3

auxiliary circuit

a circuit which is usually energized by the **auxiliary supply**.

NOTE The **auxiliary circuit** is sometimes energized by one of the input quantities.

* This publication has been replaced by IEC 60255-3:1989.

3.1.4

transducer with offset zero (live zero)

a **transducer** which gives a predetermined **output signal** other than zero when the measurand is zero

3.1.5

transducer with suppressed zero

a **transducer** for which zero **output signal** corresponds to a measurand greater than zero

3.1.6

distortion factor

the ratio of the r.m.s. value of the harmonic content to the r.m.s. value of the non-sinusoidal quantity

3.1.7

output load (for analogue signals only)

the total resistance of the circuits and apparatus connected externally across the output terminals of the **transducer**

3.1.8

ripple content (of an analogue output signal)

with steady-state input conditions, the ratio of the peak-to-peak value of the fluctuating component of an analogue output signal, expressed in percentage, to the fiducial value

3.1.9

output signal

an analogue or digital representation of the measurand

3.1.10

output power

the power at the **transducer** output terminals

3.1.11

output current (voltage) (for analogue signals only)

the current (voltage) produced by the **transducer** which is an analogue function of the measurand

3.1.12

reversible output current (voltage) (for analogue signals only)

an **output current** (voltage) which reverses polarity in response to a change of sign or direction of the measurand

3.1.13

measuring element of a transducer

a unit or module of a **transducer** which converts the measurand, or part of the measurand, into a corresponding signal.

3.1.14

single element transducer

a **transducer** having one measuring element

3.1.15

multi-element transducer

7a **transducer** having two or more measuring elements. The signals from the individual elements are combined to produce an **output signal** corresponding to the measurand

3.1.16

multi-section transducer

a **transducer** having two or more independent measuring circuits for one or more functions

3.1.17

response time

the time from the instant of application of a specified change of the measurand until the **output signal** reaches and remains at its final steady value or within a specified band centred on this value

3.1.18

compliance voltage (accuracy limiting output voltage)

for **variable output load transducers** having a current output, the value of the voltage appearing across the output terminals up to which the **transducer** complies with the requirements of this standard

3.1.19

(output) series mode interference voltage

an unwanted alternating voltage appearing in series between the output terminals and the load

3.1.20

(output) common mode interference voltage

an unwanted alternating voltage which exists between each of the output terminals and a reference point

3.1.21

storage conditions

the conditions, defined by means of the ranges of the influence quantities, such as temperature or any other special condition, within which the **transducer** may be stored (non-operating) without damage

3.1.22

stability

the ability of a **transducer** to keep its performance characteristics unchanged during a specified time, all influence quantities remaining within their specified ranges

3.1.22.1

short-term stability

the **stability** over a period of 24 h

3.1.22.2

long-term stability

the **stability** over a period of one year

3.1.23

usage group

a group of **transducers** capable of operating under a specified set of environmental conditions

3.2 Description of transducers according to the measurand

3.2.1

voltage transducer

a **transducer** used for the measurement of a.c. voltage

3.2.2

current transducer

a **transducer** used for the measurement of a.c. current

3.2.3

active power (watt) transducer

a **transducer** used for the measurement of active electrical power

3.2.4

reactive power (var) transducer

a **transducer** used for the measurement of reactive electrical power

3.2.5

frequency transducer

a **transducer** used for the measurement of the frequency of an a.c. electrical quantity

3.2.6

phase angle transducer

a **transducer** for the measurement of the phase angle between two a.c. electrical quantities having the same frequency

3.2.7

power factor transducer

a **transducer** used for the measurement of the power factor of an a.c. circuit

3.3 Description of transducers according to their output load

3.3.1

fixed output load transducer

a **transducer** which complies with this standard only when the **output load** is at its **nominal value**, within specified limits

3.3.2

variable output load transducer

a **transducer** which complies with this standard when the **output load** has any value within a given range

3.4 Nominal values

3.4.1

nominal value

a value, or one of the values, indicating the intended use of a **transducer**

NOTE The lower and upper **nominal values** of the measurand are those which correspond to the lower and upper **nominal values** of the **output signal**.

3.4.2

output span (hereinafter designated "**span**")

the algebraic difference between the upper and lower **nominal values** of the **output signal**

3.4.3

fiducial value

a value to which reference is made in order to specify the **accuracy** of a **transducer**

The **fiducial value** is the **span**, except for **transducers** having a reversible and symmetrical **output signal** when the **fiducial value** may be half the **span** if specified by the manufacturer.

3.4.4

circuit insulation voltage (nominal circuit voltage)

the highest circuit voltage to earth on which a circuit of a **transducer** may be used and which determines its voltage test

3.4.5

nominal power factor

the factor by which it is necessary to multiply the product of the nominal voltage and nominal current to obtain the nominal power

$$\text{Nominal power factor} = \frac{\text{nominal power}}{\text{nominal voltage} \times \text{nominal current}}$$

When the current and voltage are sinusoidal quantities, the **nominal power factor** is $\cos \varphi$, φ being the phase difference between the current and the voltage. For **reactive power transducers**, the **nominal power factor** is $\sin \varphi$.

3.4.6

maximum permissible values of input current and voltage

values of current and voltage assigned by the manufacturer as those which the **transducer** will withstand indefinitely without damage

3.4.7

limiting value of the output (current or voltage) signal

the upper limit of **output (current or voltage) signal** which cannot, by design, be exceeded under any conditions

3.4.8

measuring range

the range defined by two values of the measurand within which the performance complies with the requirements of this standard (see 2.4.3 of IEC 60051-1)

3.4.9

nominal value of the measured voltage

the **nominal value** of the voltage of the external circuit (e.g. the secondary winding of a voltage transformer) to which the voltage input circuit of the **transducer** is to be connected

3.4.10

nominal value of the measured current

the **nominal value** of the current in the external circuit (e.g. the secondary winding of a current transformer) to which the current input circuit of the **transducer** is to be connected

3.4.11

nominal value of the measurand

for **active power** and **reactive power transducers**, the value of the measured quantity corresponding to the **nominal values** of the measured voltage and current, and the power factor

3.5

user adjustment

transducers can be supplied with provision to be adjusted by the user. (It should be noted that power sources and measuring equipment having adequate stability and accuracy are required). The following definitions apply to these **transducers**

3.5.1

calibration value

the value of a quantity to which the **nominal value** is changed by user adjustment for a specific application

3.5.2

calibration value of the measured voltage

the value of the voltage applied to the voltage input circuit of the **transducer**

3.5.3

calibration value of the measured current

the value of the current applied to the current input circuit of the **transducer**

3.5.4

calibration value of the measurand

the value of the measurand resulting from user adjustment

3.5.5

calibration value of the output signal

the value of the **output signal** of the **transducer** corresponding to the **calibration value of the measurand** after adjustment

3.5.6

adjustment range

the possible range of adjustment values of the measured current or voltage

3.5.7

conversion coefficient

the relationship of the value of the measurand to the corresponding value of the **output signal**

3.6 Influence quantities and reference conditions

3.6.1

influence quantity

a quantity (other than the measurand) which may affect the performance of a **transducer**

3.6.2

reference conditions

the specified conditions under which the **transducer** complies with the requirements concerning **intrinsic errors**. These conditions may be defined by either a **reference value** or a **reference range**

3.6.2.1

reference value

a specified single value of an **influence quantity** at which the **transducer** complies with the requirements concerning **intrinsic errors**

3.6.2.2

reference range

a specified range of values of an **influence quantity** within which the **transducer** complies with the requirements concerning **intrinsic errors**

3.6.3

nominal range of use

a specified range of values which it is intended that an **influence quantity** can assume without the **output signal** of the **transducer** changing by amounts in excess of those specified

3.7 Errors and variations

3.7.1

error

the actual value of the **output signal** minus the intended value of the **output signal**, expressed algebraically

3.7.2

error expressed as a percentage of the fiducial value

one hundred times the ratio of the **error** and the **fiducial value**

3.7.3

intrinsic error

an **error** determined when the **transducer** is under **reference conditions**

3.7.4

variation due to an influence quantity

the difference between the two values of the **output signal** for the same value of the measurand when an **influence quantity** assumes successively two different specified values

3.7.5

variation due to an influence quantity expressed as a percentage of the fiducial value

one hundred times the ratio of the **variation due to an influence quantity** and the **fiducial value**

3.8 Accuracy, accuracy class, class index

3.8.1

accuracy

the **accuracy** of a **transducer** is defined by the limits of **intrinsic error** and by the limits of variations

3.8.2

accuracy class

a class of **transducers** the **accuracy** of all of which can be designated by the same number if they comply with all the requirements of this standard

3.8.3

class index

the number which designates the **accuracy class**

NOTE 1 The **class index** is applicable to the **intrinsic error** as well as to the variations.

NOTE 2 Throughout this standard, the phrase "x % of the **class index**" denotes "x % of the limits of **error** relating to the **class index**".

4 Class index, permissible limits of intrinsic error, auxiliary supply and reference conditions

4.1 Class index

The **class index** for a **transducer** shall be chosen from those given in table 1.

Table 1 – Relationship between the limits of intrinsic error, expressed as a percentage of the fiducial value, and the class index

Class index	0,1	0,2	0,5	1
Limits of error	±0,1 %	±0,2 %	±0,5 %	±1 %
NOTE Class indices of 0,3 and 1,5, although non-preferred, may be used.				

4.2 Intrinsic error

When the **transducer** is under **reference conditions**, the **error** at any point between the upper and lower **nominal values** of the **output signal** shall not exceed the limits of the **intrinsic error** given in table 1 expressed as a percentage of the **fiducial value**.

Values stated in a table of corrections, if any, supplied with the **transducer** shall not be taken into account in determining the **errors**.

4.3 Conditions for the determination of intrinsic error

4.3.1 Prior to pre-conditioning and before determination of the **intrinsic error**, preliminary adjustments shall be carried out in accordance with the manufacturer's instructions. The **transducer** shall be at the reference temperature.

4.3.2 The **transducer** shall be left in circuit under the conditions specified in table 2.

4.3.3 After the specified pre-conditioning, **transducers** having adjustments available to the user shall be adjusted in accordance with the manufacturer's instructions.

4.3.4 The **reference conditions** relative to each of the **influence quantities** are given in table 3. The **reference conditions** relative to the measurand are given in table 4.

Table 2 – Pre-conditioning

Conditions	Values
Voltage (including any auxiliary supply)	Nominal value
Current	Nominal value
Frequency	Reference value
Power factor	Reference value
Time between connection into circuit and start of determination of errors	30 min

4.4 Auxiliary supply

Some **transducers** dealt with in this standard may need an **auxiliary supply**. This is specified in two separate categories, d.c. and a.c. supplies.

4.4.1 D.C. supply

- a) The value of the voltage of the d.c. supply shall be as specified in 5.1.2.
- b) The battery supply may be earthed or floating. Suitable means shall be provided in the **transducer** to ensure isolation between the power supply and the input/output circuits of the **transducer** (for details of voltage tests, see 6.19).
- c) The **transducer** shall withstand any ripple up to a maximum of 10 % peak to peak, superimposed on the d.c. power supply.
- d) The noise fed back to the battery from the **transducer** shall be limited to 100 mV peak to peak when measured with a specified source resistance at all frequencies up to 100 MHz.

In addition, when the battery feeding the **transducer** is also used for telephone equipment the noise shall not exceed 2 mV psophometric.

NOTE The psophometric weighting characteristic is given in CCITT recommendation P 53.

4.4.2 A.C. supply

For the **nominal value** of the voltage of the a.c. supply see 5.1. This voltage may be provided by a separate supply or may be derived from the measured voltage.

Table 3 – Reference conditions of the influence quantities and tolerances or testing purposes

Influence quantity	Reference conditions unless otherwise marked	Tolerances permitted for testing purposes applicable to a single reference value (note 1)
Ambient temperature Usage group (see 6.1.2) I II III	To be marked 20, 23 or 27 °C 15 ... 30 °C 0 ... 45 °C	±1 °C – –
Frequency of the input quantity Non frequency sensitive	Nominal value	±2 %
Frequency sensitive	To be marked	±0,1 %
Waveform of the input quantity	Sinusoidal	The distortion factor × 100 shall not exceed the class index , unless otherwise specified by the manufacturer
Output load Fixed output load transducers	Nominal value	±1 %
Variable output load transducers	Mean value of the nominal range	±1 %
Auxiliary supply Voltage a.c.	Nominal value	±2 %
Voltage d.c.	Nominal value	±1 %
Frequency	Nominal value	±1 %
Distortion factor	0,05	–
Magnetic field of external origin	Total absence	40 A/m at frequencies from d.c. to 65 Hz in any direction (note 2)
NOTE 1 When a reference range is marked, no tolerance is allowed.		
NOTE 2 40 A/m is approximately the highest value of the earth's magnetic field.		

Table 4 – Reference conditions relative to the measurand

Measurand	Reference conditions		
	Voltage	Current	Power factor, active or reactive
Active power	Nominal voltage ±2 %	Any current up to the nominal current	cos φ = 1,0 ... 0,8 lagging or leading
Reactive power	Nominal voltage ±2 %	Any current up to the nominal current	sin φ = 1,0 ... 0,8 lagging or leading (note 1)
Phase angle or power factor	Nominal voltage ±2 %	40 ... 100 % of the nominal current	–
Frequency	Nominal voltage ±2 %	–	–
Polyphase quantities	Symmetrical voltages (note 2)	Symmetrical currents (note 2)	–
NOTE 1 Active power and reactive power transducers are normally used together and are connected to the same current and voltage transformers. It must be noted that sin φ = 1,0 ... 0,8 is used here for ease of testing only.			
NOTE 2 The difference between any two line-to-line voltages and between any two line-to-neutral voltages shall not exceed 1 % of the average (line-to-line and line-to-neutral voltages respectively). Each of the currents in the phases shall differ by not more than 1 % from the average of the currents. The angles between each of the currents and the corresponding phase-to-neutral (star) voltages shall differ by not more than 2°. Where interactions between the separate measuring elements of a multi-element transducer are adequately characterized, single-phase testing of the transducer is acceptable.			

5 Requirements

5.1 Input values

The **nominal values** of voltage, current, frequency and **auxiliary supply** shall be specified by the manufacturer.

5.1.1 Adjustment range for **transducers** which can be adjusted by the user:

- a) for the input voltage: 80 ... 120 % of the **nominal value**;
- b) for the input current: 60 ... 130 % of the **nominal value**.

This means that the **nominal value** of the **output signal** can be obtained for any adjusted value of the measurand within the ranges given above.

5.1.2 The preferred **nominal value** of d.c. auxiliary supplies shall be 24 V, 48 V or 110 V.

5.2 Analogue output signals

The lower and upper **nominal values** of the **output signal** and the **compliance voltage** shall be chosen from those given in 5.2.1 and 5.2.2 or 5.2.5.

5.2.1 Output current

The signal 4 ... 20 mA is preferred.

NOTE The condition "0 mA" has a special meaning (IEC 60381-1).

Other permissible values are:

- 0 ... 20 mA
- 0 ... 1 mA
- 0 ... 10 mA
- 1 ... 0 ... 1 mA
- 10 ... 0 ... 10 mA

5.2.2 Compliance voltage

- 10 V
- 15 V

5.2.3 The manufacturer shall state the maximum value of the **output voltage** occurring under any conditions of **output load** and input. This voltage shall not exceed the limit of safety extra-low voltage.

5.2.4 Attention is drawn to the interference problems which may result if the **output current** has a low value.

5.2.5 Output voltage

- 0 ... 1 V
- 0 ... 10 V
- 1 ... 0 ... 1 V
- 10 ... 0 ... 10 V

NOTE **Transducers** having a voltage output are non-preferred.

5.3 Digital output signals

The digital **output signals** chosen shall correspond with the requirements for **transducers** concerning **accuracy** and **response time** as well as with the requirements of the communication system.

5.4 Ripple (for analogue outputs)

The maximum **ripple content** in the **output signal** shall not exceed twice the **class index**.

5.5 Response time

5.5.1 Before determining the **response time**, the **transducer** shall be under **reference conditions** and the **auxiliary circuit** shall be energized for at least the pre-conditioning time unless it is energized from one of the input quantities and is not separately accessible.

5.5.2 The **response time** shall be stated by the manufacturer and shall be determined for an input step such that it would produce a change in **output signal** from 0 % to 90 % of the **fiducial value**.

5.5.3 If a test for decreasing input is required, the input step should produce a change in **output signal** from 100 % to 10 % of the **fiducial value**.

5.5.4 The band (see 3.1.17) shall be ± 1 % of the upper **nominal value** of the **output signal**.

5.5.5 Methods of test for **frequency transducers** and **transducers with suppressed zero** shall be stated by the manufacturer.

5.6 Variation due to over-range of the measurand

If, by agreement, a **transducer** is required to operate with an input up to 150 % of the nominal value, the difference between the **intrinsic error** at 100 % and the error at 150 % (under reference conditions) of the **nominal value** of the input shall not exceed 50 % of the class index.

For **active power** and **reactive power transducers**, 150 % of the **nominal value** is achieved by increasing the current while retaining the voltage at the **nominal value**.

5.7 Limiting value of the output signal

The **output signal** shall be limited to a maximum of twice the upper **nominal value**.

When the measurand is not between its lower and upper **nominal values**, the **transducer** shall not, under any conditions, for example over-current or under-voltage, produce an output having a value between its lower and upper **nominal values**.

5.8 Limiting conditions of operation

The limits of the **nominal ranges of use** given in clause 6 are those within which the **transducer** will comply with the requirements of this standard. It is possible to operate **transducers** beyond these limits but the user should note that:

- the **accuracy** may not be maintained and/or
- the designed operational lifetime may be reduced.

As an example, many **transducers** will operate in ambient temperatures as low as $-25\text{ }^{\circ}\text{C}$ and as high as $+70\text{ }^{\circ}\text{C}$ but the manufacturer should be consulted as to the degradation to be expected in both **accuracy** and operational lifetime.

5.9 Limits of the measuring range

When the limits of the **measuring range** do not coincide with the lower and upper **nominal values** of the output, the limits of the **measuring range** shall be marked (see 7.1 i)).

5.10 Limiting conditions for storage and transport

Unless otherwise stated by the manufacturer, **transducers** shall be capable of withstanding, without damage, exposure to temperatures within the range $-40\text{ }^{\circ}\text{C}$ to $+70\text{ }^{\circ}\text{C}$.

After returning to **reference conditions**, they shall meet the requirements of this standard.

The manufacturer shall specify any additional limiting condition required to ensure the integrity of the **transducer**.

5.11 Sealing

When the **transducer** is sealed to prevent unauthorized adjustment, access to the internal circuit and to the components within the case shall not be possible without destroying the seal.

5.12 Stability

Transducers shall comply with the relevant limits of **intrinsic error** specified for their respective **accuracy classes** for a period specified by the manufacturer, provided that the conditions of use, transport and storage specified by the manufacturer are complied with.

NOTE Usually the period will not exceed one year.

6 Tests

6.1 General

6.1.1 Determination of variations

The variations shall be determined for each **influence quantity**. During the tests, all other **influence quantities** shall be maintained at **reference conditions**.

All the **influence quantities** are given in the following subclauses, together with the appropriate testing procedure, computations and the permissible variations for each **Usage group** expressed as a percentage of the **class index**. None of the variations determined shall exceed the permissible values.

Variations shall be determined at the upper **nominal value** of the output and, at least, at one other point. For **active power** and **reactive power transducers**, these values shall be obtained by maintaining the voltage and power factor at their **reference conditions** and varying the value of the current.

When a **reference range** is specified, the **influence quantity** shall be varied between each of the limits of the **reference range** and any value in that part of the **nominal range of use** which is adjacent to the chosen limit of the **reference range**.

6.1.2 Environmental conditions

The conditions of temperature and humidity are classified according to the severity dictated by the **usage group** in accordance with table 5.

The **usage groups** given in the table correspond to the following definitions.

- I For indoor use and under conditions which are normally found in laboratories and factories and where apparatus will be handled carefully.
- II For use in locations having protection from full extremes of environment and under conditions of handling between those of Groups I and III.
- III For outdoor use and in areas where the apparatus may be subjected to rough handling.

Table 5 – Usage groups

Usage group	Nominal range of use for temperature	Relative humidity
I	10 ...35 °C	} Up to 93 ⁺² ₋₃ %
II	0 ... 45 °C	
III	-10 ... 55 °C	
NOTE For testing purposes, reference should be made to IEC 60068-2-3.		

For the purpose of this standard, ambient temperature shall be the temperature measured at a single representative point with the **transducer** operating normally. This measuring point shall be adjacent to the **transducer**, exposed to free air circulation and not significantly affected by heat from the **transducer** nor by direct solar radiation and other sources of heat.

Humidity is not considered to be an **influence quantity** provided that the environmental conditions are within the limits specified.

6.1.3 Computations

In the following subclauses, a computation is required according to a formula. The terms in the formulae follow a general principle:

- R is the value of the **output signal** under **reference conditions**.
- X (or Y) is the value of the **output signal** measured at one extreme of the **influence quantity**.
- F is the **fiducial value**.

6.2 Variations due to auxiliary supply voltage

6.2.1 Application

All **transducers** requiring a d.c. or an a.c. **auxiliary supply** except where this is obtained from the input voltage and the connections cannot be separated for testing purposes.

6.2.2 Procedure

Apply the **nominal value** of **auxiliary supply** voltage and record the value of the **output signal** (R).

At a constant value of the measurand, reduce the **auxiliary supply** voltage to the lower limit given in 6.2.4 and record the value of the **output signal** (X). Increase the **auxiliary supply** voltage to the upper limit given in 6.2.4 and record the value of the **output signal** (Y).

6.2.3 Computation

The variations are: $\frac{X-R}{F} \times 100$

and: $\frac{Y-R}{F} \times 100$

6.2.4 Permissible variations

For a.c. **auxiliary supplies**

Usage group	Nominal range of use	Variation
I	90 ... 110 %	50 %
II	80 ... 120 %	50 %
III	80 ... 120 %	50 %

For d.c. **auxiliary supplies**

Usage group	Nominal range of use	Variation
I	85 ... 125 %	50 %
II	85 ... 125 %	50 %
III	85 ... 125 %	50 %

6.3 Variations due to auxiliary supply frequency

6.3.1 Application

All **transducers** requiring an a.c. **auxiliary supply** except where this is obtained from the input voltage and the connections cannot be separated for testing purposes.

6.3.2 Procedure

Apply the **nominal value** of **auxiliary supply** frequency and record the value of the **output signal** (R). At a constant value of the measurand, reduce the **auxiliary supply** frequency to the lower limit given in 6.3.4 and record the value of the **output signal** (X).

Increase the **auxiliary supply** frequency to the upper limit given in 6.3.4 and record the value of the **output signal** (Y).

6.3.3 Computation

The variations are: $\frac{X-R}{F} \times 100$

and: $\frac{Y-R}{F} \times 100$

6.3.4 Permissible variations

Usage group	Nominal range of use	Variation
I	90 ... 110 %	50 %
II	90 ... 110 %	50 %
III	90 ... 110 %	50 %

6.4 Variations due to ambient temperature

6.4.1 Application

All **transducers**.

6.4.2 Procedure

At a constant value of the measurand and at reference temperature, record the value of the **output signal** (R).

Increase the ambient temperature to the upper limit given in 6.4.4 and allow sufficient time for conditions to stabilize (30 min is usually adequate). Record the value of the **output signal** (X).

Reduce the ambient temperature to the lower limit given in 6.4.4 and allow the same stabilization to take place. Record the value of the **output signal** (Y).

6.4.3 Computation

The variations are: $\frac{X-R}{F} \times 100$

and: $\frac{Y-R}{F} \times 100$

6.4.4 Permissible variations

Usage group	Nominal range of use	Variation
I	10 ... 35 °C	100 %
II	0 ... 45 °C	100 %
III	−10 ... 55 °C	100 %

6.5 Variations due to the frequency of the input quantity(ies)

6.5.1 Application

All **transducers** except **frequency transducers**. Frequency sensitive **transducers** (e.g. those employing phase shifting circuits) are exceptions and the **nominal range of use** shall always be marked.

6.5.2 Procedure

Apply the **nominal value** of the input frequency and record the value of the **output signal** (R).

At a constant value of the measurand, reduce the frequency to the lower limit given in 6.5.4 and record the value of the **output signal** (X).

Increase the frequency to the upper limit given in 6.5.4 and record the value of the **output signal** (Y).

6.5.3 Computation

The variations are: $\frac{X-R}{F} \times 100$

and: $\frac{Y-R}{F} \times 100$

6.5.4 Permissible variations

Usage group	Nominal range of use	Variation
I	90 ... 110 %	100 %
II	90 ... 110 %	100 %
III	90 ... 110 %	100 %
Frequency sensitive	As marked	100 %

6.6 Variations due to the input voltage

6.6.1 Application

All **transducers** except **voltage and current transducers**.

6.6.2 Procedure

Apply the **nominal value** of the input voltage and record the value of the **output signal** (R).

At a constant value of the measurand, reduce the voltage to the lower limit given in 6.6.4 and record the value of the **output signal** (X).

Increase the voltage to the upper limit given in 6.6.4 and record the value of the **output signal** (Y).

6.6.3 Computation

The variations are: $\frac{X-R}{F} \times 100$

and: $\frac{Y-R}{F} \times 100$

6.6.4 Permissible variations

Usage group	Nominal range of use	Variation
I	90 ... 110 %	50 %
II	8 ... 120 %	50 %
III	8 ... 120 %	50 %

6.7 Variations due to the input current

6.7.1 Application

Phase angle and power factor transducers.

6.7.2 Procedure

Apply the **nominal value** of the input current and record the value of the **output signal** (R).

At a constant value of the measurand, reduce the input current to the lower limit given in 6.7.4 and record the value of the **output signal** (X).

Increase the input current to the upper limit given in 6.7.4 and record the value of the **output signal** (Y).

6.7.3 Computation

The variations are: $\frac{X-R}{F} \times 100$

and: $\frac{Y-R}{F} \times 100$

6.7.4 Permissible variations

Usage group	Nominal range of use	Variation
I	20 ... 120 %	100 %
II	20 ... 120 %	100 %
III	20 ... 120 %	100 %

6.8 Variations due to power factor

6.8.1 Application

Active and reactive power transducers.

6.8.2 Procedure

Apply 50 % (5 %) of the **nominal value** of the input current at a power factor of 1,0 lag/lead respectively and record the two values of the **output signal** (R). At a constant value of the measurand, increase the input current to 100 % (10 %) of the **nominal value** and reduce the power factor to 0,5 lag/lead, respectively. Record the two values of the **output signal** (X).

For convenience, when testing the **reactive power transducers**, it is usual to apply the equivalent values of $\sin \varphi$.

Active power transducers shall also be tested for error at a power factor of zero and **reactive power transducers** at a $\sin \varphi = 0$.

6.8.3 Computation

The variations are: $\frac{X-R}{F} \times 100$

and: $\frac{Y-R}{F} \times 100$

6.8.4 Permissible variations

Usage group	Nominal range of use	Variation
I	$\cos(\sin) \varphi = 0,5 \dots 1 \dots 0,5$	50 %
II	$\cos(\sin) \varphi = 0,5 \dots 1 \dots 0,5$	50 %
III	$\cos(\sin) \varphi = 0,5 \dots 1 \dots 0,5$	50 %

For all **transducers**, the **error** at a power factor of zero (or $\sin \varphi = 0$) shall not exceed 100 % of the **class index**.

6.9 Variation due to output load

6.9.1 Application

All variable output load transducers.

6.9.2 Procedure

Apply a value of **output load** equal to the mean value of the nominal range and record the value of the **output signal** (R).

At a constant value of the measurand, reduce the resistance of the **output load** to the lower limit given in 6.9.4 and record the value of the **output signal** (X).

Increase the resistance of the **output load** to the upper limit given in 6.9.4 and record the value of the **output signal** (Y).

6.9.3 Computation

The variations are: $\frac{X-R}{F} \times 100$

and: $\frac{Y-R}{F} \times 100$

6.9.4 Permissible variations

Usage group	Nominal range OF USE	Variation
I	10 ... 100 %	50 %
II	10 ... 100 %	50 %
III	10 ... 100 %	50 %

6.10 Variations due to distortion of the input quantity(ies)

6.10.1 Application

All **transducers** characterized by the manufacturer for use on systems having distorted waveforms.

6.10.2 Procedure

Apply the chosen value of input quantity with no distortion and record the value of the **output signal** (R). Introduce third harmonic distortion at the level given in 6.10.4, maintaining the r.m.s. values constant, and record the value of the **output signal** (X). The phase relationship between the harmonic and the fundamental should be varied so as to determine the most unfavourable conditions.

For **active** and **reactive power transducers**, the test is performed with distorted current waveform and then repeated with distorted voltage waveform.

For **active** and **reactive power transducers** not employing phase shifters, the permissible variations are given in 6.10.4.

For **reactive power transducers** employing phase shifters, the permissible variations shall be specified by the manufacturer.

6.10.3 Computation

La variation est: $\frac{X-R}{F} \times 100$

6.10.4 Permissible variations

Usage group	Nominal range of use	Variation
I	Distortion factor 0,2	200 %
II	Distortion factor 0,2	200 %
III	Distortion factor 0,2	200 %

6.11 Variation due to magnetic field of external origin

6.11.1 Application

All **transducers**.

6.11.2 Procedure

The **transducer** is placed in the centre of a coil of 1 m mean diameter, of square cross section and of radial thickness small compared with the diameter (Note). 400 ampere-turns in this coil will produce, at the centre of the coil, in the absence of the **transducer** under test, a magnetic field strength of 0,4 kA/m. The magnetic field shall be produced by a current of the same kind and frequency as that which energizes the measuring circuit and shall be such as to have the most unfavourable combination of phase and orientation. The values of a.c. fields are expressed in r.m.s. values.

Any **transducer** having an external dimension exceeding 250 mm shall be tested in a coil of mean diameter not less than four times the maximum dimensions of the **transducer**. The magnetic field strength being the same as that given above.

NOTE Other devices which produce an adequate homogeneous magnetic field in the absence of the **transducer** under test are also permissible.

In the absence of the external field, record the value of the **output signal (R)**.

At a constant value of the measurand, apply the external field and record the value of the **output signal (X)**.

6.11.3 Computation

The variation is: $\frac{X-R}{F} \times 100$

6.11.4 Permissible variations

Usage group	Variation
I	100 %
II	100 %
III	100 %

6.12 Variation due to unbalanced currents

6.12.1 Application

Multi-element **active** and **reactive power transducers**.

6.12.2 Procedure

The currents shall be balanced and adjusted so that the **output signal** is approximately in the middle of the **span** or, if zero **output signal** is within the span, half-way between zero and the upper **nominal value** of the **output signal**. Record the value of the **output signal** (R).

Disconnect one current, maintaining the voltages balanced and symmetrical, and adjust the other currents, maintaining them equal, so as to restore the initial value of the measurand.

Record the value of the **output signal** (X).

6.12.3 Computation

The variation is: $\frac{X-R}{F} \times 100$

6.12.4 Permissible variations

Usage group	Variation
I	100 %
II	100 %
III	100 %

6.13 Variation due to interaction between measuring elements

6.13.1 Application

All multi-element **active power** and **reactive power transducers** except those employing two measuring elements for measuring three-phase four-wired unbalanced power with three current circuits (sometimes known as "two and a half elements") and those **reactive power transducers** using cross-connection methods.

6.13.2 Procedure

The voltage input of one measuring circuit alone shall be energized at nominal voltage. The current input of each of the other measuring circuits shall be energized in turn at nominal current. The maximum departure of the **output signal** (X) from that corresponding to zero of the measurand shall be noted whilst the phase angle between the voltage and currents is changed through 360°.

If the **auxiliary supply** is common to one of the voltage input circuits, this circuit shall be the one to which the voltage is applied.

6.13.3 Computation

The variation is: $\frac{X}{F} \times 100$

6.13.4 Permissible variations

Usage group	Variation
I	50 %
II	50 %
III	50 %

6.14 Variation due to self-heating

6.14.1 Application

All transducers.

6.14.2 Method

The **transducer** shall be at ambient temperature and shall have been disconnected for at least 4 h. Energize the **transducer** in accordance with 4.3.2 (except for the condition of "30 min" as specified in table 2).

After 1 min and before the third minute, determine the value of the **output signal** (X). Repeat this procedure between the 30th and 35th minute after energization (R).

6.14.3 Computation

The variation is:
$$\frac{R - X}{F} \times 100$$

6.14.4 Permissible variations

Usage group	Variation
I	100 %
II	100 %
III	100 %

6.15 Variation due to continuous operation

6.15.1 Application

All transducers.

6.15.2 Procedure

Energize the **transducer** under **reference conditions** for at least the preconditioning period. Record the value of the output (R). After a convenient period of continuous operation, for example 6 h, note the value of the output (X).

6.15.3 Computation

The variation is:
$$\frac{X - R}{F} \times 100$$

6.15.4 Permissible variation

A variation is allowed but the **transducer** shall continue to comply in all respects with the requirements appropriate to its **accuracy class**.

6.16 Variation due to common mode interference

6.16.1 Application

All **transducers** having an analogue **output signal**.

6.16.2 Procedure

At a constant value of the measurand near the upper **nominal value**, record the value of the **output signal** (R). Apply a voltage of 100 V r.m.s., at 45 Hz to 65 Hz, between either output terminal and earth. Record the value of the **output signal** (X).

6.16.3 Computation

The variation is: $\frac{X - R}{F} \times 100$

6.16.4 Permissible variations

Usage group	Variation
I	100 %
II	100 %
III	100 %

6.17 Variation due to series mode interference

6.17.1 Application

All **transducers** having an analogue current **output signal**.

6.17.2 Procedure

At a constant value of the measurand near the upper **nominal value** and with the **compliance voltage** at 80 % of the maximum value, record the value of the **output signal** (R).

Apply a voltage of 1 V r.m.s. at 45 Hz to 65 Hz, in series with the **output signal**. Record the value of the **output signal** (X).

NOTE The internal d.c. resistance of the source of the series-mode interference, if excessive, may influence the test results, especially for the fixed output load transducers.

6.17.3 Computation

The variation is: $\frac{X - R}{F} \times 100$

6.17.4 Permissible variations

Usage group	Variation
I	100 %
II	100 %
III	100 %

6.18 Permissible excessive inputs

After completion of the tests described in 6.18.1 and 6.18.2 and after having regained equilibrium with the **reference value** of the ambient temperature, the **transducer** shall comply with the requirements appropriate to its **class index**.

6.18.1 Continuous excessive inputs

The **transducer** shall withstand the application of excessive inputs simultaneously for 24 h.

- a) Voltage inputs, including auxiliary supplies, shall be subjected to 120 % of the **nominal value** of the voltage.
- b) Current inputs shall be subjected to 120 % of the **nominal value** of the current.

6.18.2 Excessive inputs of short duration

The tests shall be made under **reference conditions**. The excessive input amplitudes of short duration which shall be applied to **transducers** are:

- a) for voltage inputs: 200 % of the **nominal value** of the **measured voltage** applied for 1 s and repeated 10 times at 10 s intervals;
- b) for current inputs: 20 times the **nominal value** of the **measured current** applied for 1 s and repeated 5 times at 300 s intervals.

The test circuit shall be substantially non-reactive.

6.19 Voltage test, insulation tests and other safety requirements

The requirements for the voltage test and other safety requirements are included in IEC 61010-1 to which reference shall be made.

6.20 Impulse voltage tests

6.20.1 A peak test voltage of 5 kV in both positive and negative senses, having the standardized impulse waveform of 1,2/50 μ s, shall be applied to **transducers** as follows:

- between the earth terminal and all the other terminals connected together;
- between the terminals of each circuit in turn, all other circuits being earthed.

Three positive and three negative impulses shall be applied at intervals of not less than 5 s. Any flashover (capacitance discharge) shall be considered a criterion of failure unless occurring in a component designed for such.

For further details of the impulse voltage test, reference should be made to IEC 60521.

6.20.2 After completion of the impulse voltage test, the **transducer** shall comply with the requirements appropriate to its **class index**.

6.20.3 Auxiliary circuits with a reference voltage of over 40 V shall be subjected to the impulse voltage test under the same conditions as those already given for the other circuits.

6.21 High frequency disturbance test

See the IEC 61000-4 series of publications.

6.22 Test for temperature rise

The **transducer** shall be energized as follows:

- each current circuit shall carry a current of 1,1 times the nominal current and
- each voltage circuit shall be supplied with a voltage of 1,2 times the nominal voltage.

These conditions shall be maintained for at least 2 h. During the test the **transducer** shall not be exposed to forced ventilation nor to direct solar radiation.

The temperature rise of the following parts of the **transducer** shall not exceed:

- for input circuits: 60 K;
- for the exterior surface: 25 K.

6.23 Other tests

If, by agreement, other tests are required, refer to the following publications:

- for vibration: IEC 60068-2-6;
- for shock: IEC 60068-2-27;
- for drop and topple: IEC 60068-2-31;
- for electromagnetic compatibility: the IEC 61000-4 series of publications.

7 Marking

7.1 Marking on the case

Transducers shall bear, on (or visible through) one of the external surfaces of the case, the markings listed below. The markings shall be legible and indelible. The symbols referred to below are specified in table 7.

- Manufacturer's name or mark.
- Manufacturer's type designation.
- Serial number or date code.
- Class index** (symbol E-10 or E-11).
- Nature of the measurand and number of circuits (symbol B-2, B-4 or B-6 to B-10).
- Lower and upper **nominal values** of the measurand.
- Ratios of current transformers and voltage transformers, if any, with which the **transducer** is intended to be used.
- Range of values of the **output current (voltage)** and **output load** within which specified operation is obtained (analogue signals only).
- Limits of the **measuring range**, if appropriate (see 5.9).
- Serial number(s) of the associated equipment, if applicable.
- Deleted
- Value(s) of the **auxiliary supply**, if relevant.
- Symbol showing that some other essential information is given in a separate document (symbol F-33).
- Space for adjustment data (if appropriate).
- Nominal range of use** for temperature, symbolized as usage group I, II or III.

- p) Common mode voltage (note).
- q) Overvoltage category (see IEC 61010-1, amendment 2, subclause 5.1.5).
- r) Pollution degree according to IEC 61010-1.
- s) Other required safety symbols according to IEC 61010-1.

If the markings and symbols are on an easily removable part, such as a cover, the **transducer** shall have a serial number which shall also be marked on the body of the **transducer**.

Transducers having a non-linear relationship between input and output shall be marked with the symbol F-33, and actual relationship between input and output shall be given in a separate document.

NOTE To be given if there is sufficient space on the case, otherwise to be given in a separate document.

7.2 Markings relating to the reference conditions and nominal ranges of use for transducers

7.2.1 The **reference values** (or **ranges**) and **nominal ranges** of use, if different from those given in tables 3 and 4 and clause 6, shall be marked on the **transducer** or given in a separate document.

7.2.2 When a **reference value** or a **reference range** is marked, it shall be identified by underlining.

7.2.3 Table 6 shows the significance of the various markings, for example for temperature.

Table 6 – Examples of marking relating to the reference conditions and nominal range of use for temperature

Three or four numbers shall always be used.

Example	Meaning
10 ... <u>23</u> ... 35 °C	Conforms to Group I
0 ... <u>15</u> ... <u>30</u> ... 45 °C	Conforms to Group II
–10 ... <u>0</u> ... <u>45</u> ... 55 °C	Conforms to Group III
0 ... <u>25</u> ... 40 °C	Reference value: 25 °C Nominal range of use: 0 °C to 40 °C
–5 ... <u>20</u> ... <u>30</u> ... 35 °C	Reference range: 20 °C to 30 °C Nominal range of use: –5 °C to 35 °C

7.3 Identification of connections and terminals

If so required for the correct use of the **transducer**, a diagram or table of connections shall be supplied and the terminals shall be clearly marked to show the proper method of connection.

If a terminal of a measuring circuit is intended to be kept at, or near to earth (ground) potential (for example, for safety or functional reasons), it shall either be marked with a capital N if it is intended to be connected to the neutral conductor of an a.c. supply circuit, or it shall be marked with symbol F-45 (see table 7) in all other circumstances.

The earthing terminal(s) shall be marked using symbol(s) F-31 and/or F-42 to F-45, as appropriate.

7.4 Information to be given in a separate document

The following information shall be given in the document supplied with the **transducer**:

- **response time**;
- the variation due to a magnetic field of external origin;
- the actual relationship between input and output if it is non-linear.

Table 7 – Symbols for marking transducers

No.	Item	Symbol
B Nature of input quantity(ies) and number of measuring circuits		
B-1	D.C. circuit (for auxiliary supply only)	
B-2	A.C. circuit (single phase)	
B-3	D.C. and a.c. circuit	
B-4	Three-phase a.c. circuit (general symbol)	3 
B-6	One measuring element for three-wire network	3  1E
B-7	One measuring element for four-wire network	3N  1E
B-8	Two measuring elements for three-wire network with unbalanced load	3  2E
B-9	Two measuring elements for four-wire network with unbalanced load	3N  2E
B-10	Three measuring elements for four-wire network with unbalanced load	3N  3E
C Safety (see IEC 61010-1)		
E Accuracy class		
E-10	Class index (e.g. 1) when the fiducial value corresponds to the span	1
E-11	Class index (e.g. 0,5) when the fiducial value corresponds to half the span	0,5 / 0,5
F General symbols		
F-31	Earth (ground) terminal (general symbol)	
F-33	Refer to a separate document	
F-42	Frame or chassis terminal	
F-43	Protective earth (ground) terminal	
F-44	Noiseless earth (ground) terminal	
F-45	Measuring circuit earth (ground) terminal	
F-46	Positive terminal	
F-47	Negative terminal	

Annex A
(informative)

Bibliography

IEC 60051, *Direct acting indicating analogue electrical measuring instruments and their accessories*

IEC 60068-2-6:1995, *Environmental testing – Part 2: Tests – Test Fc and guidance: Vibration (sinusoidal)*

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests – Test Ea and guidance: Shock*

IEC 60068-2-31:1969, *Environmental testing – Part 2: Tests – Test Ec: Drop and topple, primarily for equipment-type specimens*

IEC 60381-1:1982, *Analogue signals for process control systems – Part 1: Direct current signals*

(Continued from second cover)

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
IEC 60521 : 1988 Class 0.5, 1 and 2 alternating-current watt-hour meters	IS 13010 : 2002 ac Watthour meters, Class 0.5, 1 and 2 — Specification	Technically Equivalent
IEC 61010-1 : 2001 Safety requirements for electrical equipment for measurement, control and laboratory use — Part 1: General requirements	IS 9249 (Part 1) : 2010/IEC 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use: Part 1 General requirements (<i>under printing</i>)	Identical

In addition to the above the Technical Committee responsible for the preparation of this standard has reviewed the provision of the following International Standards referred to in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

<i>International Standard</i>	<i>Title</i>
IEC 60050 Chapter 303 : 1983	Electrotechnical Vocabulary (IEV). Chapter 303: Electronic measuring instruments
IEC 61000-4	Electromagnetic compatibility (EMC) — Part 4: Testing and measuring techniques

Only the English language text the International Standard has been retained while adopting it as an Indian Standard, and as such the page numbers given here are not the same as in IEC Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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Amendments Issued Since Publication

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Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	{ 2254 1216, 2254 1442 2254 2519, 2254 2315
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400093	{ 2832 9295, 2832 7858 2832 7891, 2832 7892

Branches: AHMEDABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. DEHRADUN. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAJKOT. THIRUVANATHAPURAM. VISAKHAPATNAM.